

metal components are present as exchanged species, as in original claim 23. They also specify that the matrix material is alumina, silica-alumina with clay, as described on page 17, lines 27 -29 of the specification. Claim 30 has been cancelled as redundant in view of the requirement in claim 25 that it is formulated as an integrated cracking/sulfur reduction catalyst.

4.1 The Examiner has rejected claims 17 -18, 21 - 27 and 30 under 35 USC 102(b) as anticipated by Vasalos U.S. 4,153,535.

4.2. Vasalos relates to catalytic materials which are useful for the reduction of carbon monoxide (CO) and sulfur oxides (SOx) from the stack gases from FCC regenerators (column 3, lines 31-33). The catalytic material may be in the form of solid particles which contain a molecular sieve such as a zeolite (column 3, lines 39-45; column 9, lines 47-48, line 63 et seq). The material contains a "metallic reactant" (column 4, lines 24-26) which reacts with sulfur oxides to form a metal and sulfur containing compound. In addition, a "metallic promoter" or "metallic oxidation promoter" is present for the oxidization of carbon monoxide and sulfur oxide; this component is separate from the "metallic reactant" (column 4, lines 29, 36-37; column 6, lines 4-6, 18-22; column 14, lines 32-33, 40-42, 47-48, 63-64; column 15, lines 7, 12-15; column 20, lines 9-13).

4.2. The metallic reactant and the metallic promoter may be present as a powder separate from the sieve type cracking catalyst (column 13, lines 62-68) or, alternatively, may be incorporated onto a suitable support (column 14, line 33) which is then admixed with the sieve type cracking catalyst (column 145, lines 39-42). Another alternative is that the metallic promoter or reactant or both may be incorporated into the sieve type cracking catalyst (column 14, lines 47-51). This case, the metallic components can be introduced into the catalyst matrix during manufacture of impregnated onto the catalyst structure (column 14, lines 51-55). It is stated that the precise manner in which the the metal or metals of the metallic promoter or the metallic reactant or both are incorporated into the molecular sieve type cracking catalyst, amorphous cracking catalyst or substantially inert substrate is not known with certainty (column 14, lines 62-68). The use of both ion exchange and impregnation techniques is referred to (column 15, lines 7-15) with a distinction drawn between impregnation and ion-exchange (column 15, lines 52-57).

4.3. The metallic reactant (which reacts with the sulfur oxides to form a metal and sulfur containing compound) may be a rare earth metal (column 5, lines 18-23). The metallic promoter (the component which promotes oxidization of carbon monoxide and sulfur oxides) is a free or combined metallic element which may be vanadium (column 4, lines 65-68; column 5, line 4). An example of the use of vanadium is provided in Example 17, where vanadium together with copper (as the "metallic reactant") is impregnated onto amorphous alumina using ammonium vanadate and oxalic acid.

4.4. The relevant portion of the Vasalos disclosure is the part dealing with the incorporation of the metallic reactant and the metallic promoter into molecular sieve type cracking catalysts (column 14, lines 47-62). Here, the following is stated:

In such case, the metallic promoter or metallic reactant or both can be introduced *into the cracking catalyst matrix* during the catalyst manufacture or can be *impregnated* on the cracking catalyst structure. (Column 14, lines 51-55, emphasis added).

Thus, two possibilities are envisaged by this disclosure: first that the metallic components (the metallic reactant and the metallic promoter) are to be put onto the catalyst matrix or, second, that they are to be put onto the catalyst "structure" (undefined but presumably the entire catalyst apart from these components) by the process of impregnation.

4.5. Now, the first of these two possibilities does not admit of making a catalytic material of the type contemplated by the present claims. The present claims are directed to a material in which the vanadium and the second (rare earth) metal component are located within the pore structure of the molecular sieve, which is, by definition separate from the amorphous matrix material (alumina, silica-alumina). If the metal components of the Vasalos composition are introduced into the matrix, it follows that they are not introduced into the sieve (e.g. zeolite), so that they will not be present in the form required by the present claims, in an oxidation state greater than zero within the interior pore structure of the molecular sieve.

4.6. Similarly, the second described alternative does not disclose or suggest the presently claimed compositions. Here, the process of impregnation is used to introduce the metallic components onto the cracking catalyst structure. Impregnation is, as noted above, distinguished from ion-exchange. See Vasalos column 15, lines 52 to 57. This distinction is the more telling in the case of vanadium if that metal is selected as the metallic promoter since vanadium is capable of existing in both cationic and anionic forms. Cationic forms include the simple vanadium cation as well as vanadyl whereas the relatively numerous anionic forms containing vanadium in various oxidation states such as vanadium (IV) and vanadium (V), include vanadate, ortho-vanadate, pyro-vanadate and meta-vanadate. The use of such anionic vanadium species for the purpose of introducing vanadium into refining catalysts is well established, for example, in the manufacture of hydroprocessing catalysts. These forms cannot, of course, by reason of their anionic condition, be exchanged onto the sieve component which will undergo only cation exchange. Given the existence of these different possibilities, and the failure of the Vasalos disclosure to distinguish between them, it follows that Vasalos does not describe vanadium as being present in the product in the form required by the present claims, namely, in an oxidation state greater than zero within the interior structure of the sieve component.

5. The rejection under 35 USC 102(e) based on Huang, U.S. 5,705,729, was not applied to claim 21 which specifies that the first metal component is vanadium. As claim 17 now specifies that vanadium is the selected metal, it is assumed that this rejection is no longer applicable. Huang, it is noted, does not disclose the use of vanadium as a component of his catalysts.

6.1. Claims 19-20 and 28-29 are rejected as unpatentable (35 USC 103(a)) over Vasalos in view of Chu or Miller. The gravamen of this rejection is the use of zeolite USY as the molecular sieve component of the composition, as indicated by the Examiner's comments.

6.2. As discussed above, Vasalos does not disclose or suggest the use of vanadium in the catalytic materials described there in the form required by the present claims. For this reason, the rejection based on this reference should be reconsidered. The addition of the Chu and Miller references does alter the situation since they do not indicate any

significant feature beyond certain properties and characteristics of zeolite USY. They fail to supplement the Vasalos disclosure with respect to the teachings of the metal components.

7. The Section 103(a) rejection based on Huang as applied to claims 17-20, 23-25 and 28-30 is assumed to be no longer applicable since Huang, which does not disclose or suggest the use of vanadium in its catalysts, was not applied to claim 22 specifying this feature, now appearing in claim 17.

8.1. The rejection based on Fischer (U.S. 5,705,729), Miller (U.S. 4,340,465) and Scherzer (U.S. 3,676,368) is not thought to be warranted by the facts. The rejection is applied to claims all of which specify that the catalytic composition is a fluidizable catalyst with a particle size in the range of 20 to 100 microns. Fischer, by contrast deals with a hydrocracking process: there is no suggestion or implication in Fischer that its prescriptions would be applicable to the very different technology of fluid catalytic cracking. The hydrocracking process and the FCC process are recognized in the art as being very different: FCC is a strongly endothermic process carried out in the absence of added hydrogen under conditions of high temperature, typically above 500°C, with heat provided by the exothermic regeneration whereas hydrocracking is exothermic and is carried out in the presence of major quantities of added hydrogen at temperatures which rarely exceed 425°C, normally with quench to maintain temperatures within the desired range. Hydrocracking is carried out with a fixed bed of catalyst in which the particles are typically several millimeters in length and diameter whereas FCC is, by definition, carried out with a fluidizable catalyst with catalyst particles in the range of 20 to 100 microns. Hydrocracking catalysts typically include a metal component (to facilitate hydrogenation-dehydrogenation reactions) and this component may often include vanadium but the FCC process is not merely adversely affected by hydrogenation-dehydrogenation reactions taking place in the presence of metals such as nickel but can also be severely affected by vanadium (see the Wormsbecher references). In hydrocracking, extended catalyst activity is normal and expected - often for a period of three years - but in FCC, active catalyst life is no more than ten seconds. Further differences could be adduced by thee will suffice: the point is that the conditions and material used in hydrocracking cannot be readily applied to FCC and the catalysts used in it. It would therefore not have been obvious for the skilled person to apply

Fischer's teachings to the art of FCC or the catalysts used in the FCC process, as are claimed in the present claims.

8.2. With this basic fact established, it is submitted that the person of ordinary skill in the art would not have sought to use Fischer's teachings in combination with those of Miller or Schertzer. Miller is concerned with fluid catalytic cracking catalysts (the process is carried out in the absence of hydrogen (column 2, line 64) and Scherzer is concerned only with catalytic cracking, either of the fluidized or moving bed types (column 3, lines 2-32). Even the moving bed type of cracking process is not considered in the art to be analogous to hydrocracking in view of its operation at high temperatures in the absence of added hydrogen with a short active catalyst life. The Examiner's combination of the Fischer, Miller and Schertzer teachings is therefore not warranted by the facts and should be reconsidered.

8.3. The Examiner's suggestion that size is normally recognized as being within the ordinary level of skill in an art is recognized for what it is: a principle of widespread but not universal application. It is submitted that this principle although of widespread application does not apply when the size makes a qualitative difference to the issue as it does here where what is being claimed is a fluidizable catalytic cracking catalyst, not a hydrocracking catalyst. As pointed out above, an FCC catalyst is qualitatively different to a hydrocracking catalyst and one of the incidences of this difference is their particle size which is therefore appropriately referred to in the claims. Thus, any legal principle that might be extracted from the *Rose* case, a decision on a simple mechanical matter relating to lumber packages, is inapplicable here. In any event, legal precedent does not create fact.

9. The rejection based on Chester, U.S. 4,437,978, with Vasalos was not applied to claim 21, specifying the presence of vanadium as the first metal component of the catalyst. It is therefore taken that this rejection will no longer be applicable but for completeness, Applicant notes that Chester which is concerned with FCC catalysts, refrains from suggesting the utility of vanadium and that this deficiency (from the viewpoint of the rejection) is not supplied by Vasalos for the reasons noted above with respect to that reference.

10.1. The rejection based on Walker, Miller or Scherzer with Vasalos, is not justified with respect to the claims as now stated. It is noted that this rejection was not applied to claim 23 (now cancelled since claim 17 specifies that the two metal components are present as exchanged species within the zeolite pores in oxidation states greater than zero).

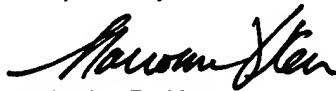
10.2. The Walker reference discloses the use of cracking catalysts which are based on pure silica matrix materials in which the active zeolite cracking component, e.g. zeolite Y, is embedded (Walker '960, column 1, lines 42-43). In addition to the silica matrix and the zeolite, the catalyst contains at least one vanadium oxide (column 1, line 46) in an amount which has been found to be effective for alleviating the problem of deactivation by the presence of vanadium in the cracking feeds (column 1, lines 21-25). The patent stresses the importance of using a pure silica matrix material for the catalyst: see column 8, lines 42-50.

10.3. By contrast, the claims of the present application are directed to the use of molecular sieves which contain vanadium as well as a rare earth component in matrices which are based on alumina or silica-alumina with added clay, as described in the original text at page 17, lines 27-30. Since the Walker references teach away from the use of matrices other than pure silica (see column 8, lines 42-50), it is believed - and it is so submitted - that the claims are patentable over the Walker reference, either alone or in combination with the remaining references adduced in support of this rejection. Further, the Walker references do not disclose the desirability of using the vanadium component in addition to the rare earth component exchanged as cationic species in an oxidation state greater than zero within the zeolite pores, with the objective of reducing liquid product sulfur content.

11. In view of the amendments and remarks set out above, allowance of the application is requested.

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Serial No. 09/468,452
Amended claims
Version mark d to show changes



17. (Amended) A fluidizable catalytic cracking product sulfur reduction catalyst for reducing the sulfur content of a catalytically cracked gasoline fraction during the catalytic cracking process, which comprises fluidizable particles having a size range from about 20 to about 100 microns of (i) a porous molecular sieve component in a matrix comprising alumina or silica-alumina with clay, (ii) a first metal component comprising vanadium metal in an oxidation state greater than zero located within the interior pore structure of the porous hydrocarbon cracking component and (iii) a second metal component comprising cerium located within the interior pore structure of the porous molecular sieve, in which the metal components have has been introduced into the zeolite as exchanged cationic species within the zeolite pores.

25. (Amended) A fluidizable catalytic cracking product sulfur reduction catalyst according to claim 17 formulated as an integrated fluidizable cracking/product sulfur reduction catalyst for cracking a heavy hydrocarbon feed to produce liquid cracking products including gasoline and reducing the sulfur content of the catalytically cracked gasoline fraction during the catalytic cracking process, which comprises fluidizable particles having a size ranging from about 20 to about 100 microns of a zeolite hydrocarbon cracking catalyst component in a matrix comprising alumina or silica-alumina with clay, the zeolite, having a bulk silica:alumina ratio of at least 5.0 which contains located within the pore structure of the zeolite (i) a first metal component which comprises at least one metal of Period 3, Groups 5, 8, 9 or 12 of the Periodic Table vanadium in an oxidation state greater than zero and (ii) and a second metal component which comprises cerium, in which the metal components have has been introduced into the zeolite as exchanged cationic species within the zeolite pores.

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Serial No. 09/468,452
Amended claims
Version marked to show changes



17. (Amended) A fluidizable catalytic cracking product sulfur reduction catalyst for reducing the sulfur content of a catalytically cracked gasoline fraction during the catalytic cracking process, which comprises fluidizable particles having a size range from about 20 to about 100 microns of (i) a porous molecular sieve component in a matrix comprising alumina or silica-alumina with clay, (ii) a first metal component comprising vanadium metal in an oxidation state greater than zero located within the interior pore structure of the porous hydrocarbon cracking component and (iii) a second metal component comprising cerium located within the interior pore structure of the porous molecular sieve, in which the metal components have been introduced into the zeolite as exchanged cationic species within the zeolite pores.

25. (Amended) A fluidizable catalytic cracking product sulfur reduction catalyst according to claim 17 formulated as an integrated fluidizable cracking/product sulfur reduction catalyst for cracking a heavy hydrocarbon feed to produce liquid cracking products including gasoline and reducing the sulfur content of the catalytically cracked gasoline fraction during the catalytic cracking process, which comprises fluidizable particles having a size ranging from about 20 to about 100 microns of a zeolite hydrocarbon cracking catalyst component in a matrix comprising alumina or silica-alumina with clay, the zeolite, having a bulk silica:alumina ratio of at least 5.0 which contains located within the pore structure of the zeolite (i) a first metal component which comprises at least one metal of Period 3, Groups 5, 8, 9 or 12 of the Periodic Table vanadium in an oxidation state greater than zero and (ii) and a second metal component which comprises cerium, in which the metal components have been introduced into the zeolite as exchanged cationic species within the zeolite pores.

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